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Substrate-induced Strain Effect on the Planar Hall Effects of $La_{0.7}Sr_{0.3}MnO_3$ thin Films

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Magnetic anisotropy (in-plane and out-of-plane) is generated due to the strain effect in the $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) film grown on various substrates with different lattice constant. Here, we show that the change of anisotropic magnetoresistance (AMR) and planar Hall effect (PHE) in LSMO film due to the in-plane anisotropy which is caused by strain effect. Epitaxial LSMO thin films were grown on (001) $SrTiO_3$ (STO), (001) MgO and (001) $LaAlO_3$ (LAO) single crystal substrates by pulsed laser deposition. The processing parameters, including target-to-substrate distance (D_{TS}), oxygen pressure (P_{o2}), and substrate temperature (T_S), were optimized to obtain high quality LSMO films. The magnetic properties of epitaxial films, particularly magnetic anisotropy and Curie temperature, exhibit a close correlation with the lattice strains LSMO films induced by lattice mismatch with the substrates. For the measurements of longitudinal resistance (anisotropic magnetoresistance) and transverse (planar hall) resistance, the films were patterned into hall bars with a dimension of 4 x 0.1 mm^2 using photolithography and chemical etching, and Au electrode was deposited using E-beam evaporation. AMR and PHE resistance were measured by the vibrating sample magnetometer (VSM) for LSMO films with their current paths parallel to their magnetic easy axis and hard axis directions. Angular dependence of planar hall resistance was obtained when in-plane magnetic field was applied. In low fields, the jumps observed in the AMR and PHE resistances occurred at the coercive fields of LSMO films.